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Introduction

Several recently-developed herbicides provide postemergence control of annual and perennial grasses in soybeans [*Glycine max* (L.) Merr.]. These herbicides have been very effective in controlling grasses with no injury to soybeans. To facilitate broad spectrum weed control and to reduce costs, tank mixes of grass and broadleaf herbicides are frequently used. Although herbicide combinations may encourage a broader spectrum of weed control, tank mixing may produce undesirable interactions, mainly reduced grass activity (Rhodes and Coble, 1984; Vidrine, et al., 1986). In some instances, this antagonism may be counteracted by using higher rates of the grass herbicide. However, the cost effectiveness of this measure is sometimes questionable.

Soil moisture also has been shown to affect the consistency of performance of graminicides (Dortenzio, et al., 1980; Godley, et al., 1986; McWhorter, 1979). Dortenzio suggsted that a loss in activity occurred when diclofop (Hoelon) was applied under low soil moisture conditions. In Louisiana, Retzinger et al. reported that the degree of weed control with Fusilade was more strongly associated with rainfall conditions than with the size of seedling and rhizome johnsongrass [*Sorghum halepense* (L.) Pers.]. The studies reported upon in this publication were conducted to further investigate the potential antagonism associated with postemergence application of grass and broadleaf herbicides tank mixtures.

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Materials and Methods

Field studies were conducted at Alexandria, Baton Rouge, Crowley, and St. Joseph, La. in 1983, 1984, and 1985. Graminicide treatments consisted of applications of Assure, Fusilade 2000, Poast, Verdict, and Whip at 0.19, 0.19, 0.30, 0.19, and 0.15 pounds of active ingredient per acre, respectively. These herbicides were applied alone and in combination with commonly-used broadleaf herbicides. The broadleaf herbicides and herbicide combinations consisted of Basagran, Basagran + Blazer, Blazer, Classic, Cobra, Reflex, and Scepter at 0.75, 0.75 + 0.375, 0.375, 0.008, 0.20, 0.375, and 0.125 pounds of active ingredient per acre, respectively.

Weed control was evaluated visually to determine if the tank mixtures reduced efficacy of the graminicides over that of graminicides applied alone. Treatments were applied with crop oil concentrate at 1 percent v/v of the total spray solution, with the exception of Whip to which no adjuvant was added. Although methodology differed slightly at each location, visual ratings, analysis of data, and application equipment were the same.

Visual ratings of grass control and crop injury were based on a scale of 0 percent (no effect) to 100 per cent (complete grass control, or crop injury relative to untreated check plots). These ratings were conducted by the same evaluators each year at each location.

An analysis of variance was performed on ratings at each location, and means were separated using Duncan's multiple range test. Significance is reported at a level with $P = 0.05$. A significant year by treatment interaction was found for each location; consequently, data are presented for individual years. At all locations herbicides were applied with tractor-mounted compressed-air sprayers at volume of 10-20 gallons per acre.

Alexandria. Field studies were conducted in 1984 and 1985 at the Dean Lee Research Station on a Norwood silt loam soil (Typic Udifluvents). The test area had a uniform and dense natural population of seedling and rhizome johnsongrass. Centennial variety soybeans were planted May 31, 1984, and May 28, 1985. Plots consisted of two 38-inch spaced rows 50 feet in length, with an untreated border row separating each plot. Treatments were replicated four times in a randomized complete block design. In 1984, herbicides were applied three weeks after planting when soybeans were eight inches tall and in the V4 growth stage (Table 2). In 1985, soybeans were 12 inches tall and in the V5 growth stage. Herbicide treatments are shown in tables 1-5.

Baton Rouge. Field experiments were conducted at the Ben Hur Research Farm in 1984 and 1985 on a Mhoon silty clay loam soil (Typic Fluvoquent). Davis variety soybeans were planted on May 31, 1984, and Centennial soybeans were planted on May 5, with replanting on May 30,

1985, on 30-inch row spacings. Plots were four rows wide by 20 feet long in 1984, and three rows wide by 25 feet long in 1985. An untreated border row separated each plot, in addition to a separate check plot for each replication for each year. Treatments were replicated four times in a randomized block design. Herbicides were applied five and four weeks after planting in 1984 and 1985, respectively. In 1984, soybeans had eight trifoliate leaves, and in 1985, two trifoliate leaves. Herbicide treatments are shown in tables 1-5.

St. Joseph. Field experiments were conducted at the Northeast Research Station in 1984 and 1985 on a Commerce silt loam soil (Aeric Fluvoquent). The experimental design was a randomized complete block with three replications in 1984 and four in 1985. The soil was disked each year to a 4-6-inch depth, and beds were prepared on 36-inch centers. The plots were two rows wide by 50 feet long, with a separate check plot for each replication for each year. Forrest variety soybeans were planted on May 14, 1984, and Bragg soybeans on May 16, 1985. Herbicides were applied four weeks after planting in 1984, and three weeks after planting in 1985. In 1984, soybeans were at the V4-V5 stage of growth, seedling johnsongrass was 8-20 inches, and broadleaf signalgrass was 8-10 inches. In 1985, soybeans were at the V3-V4 growth stage, seedling johnsongrass was 6-18 inches, and broadleaf signalgrass was 1-3 inches. Herbicide treatments applied in 1984 and 1985 are shown in tables 1-6.

Crowley. Field studies were conducted in 1983 and 1984 at the Rice Research Station on a Crowley silt loam soil (Typic Albqualf). Centennial variety soybeans were planted on June 3, 1983, in 20-inch row spacings. In 1984, Ransom soybeans were planted on June 1 in 30-inch row spacings. Treatments were replicated four times in 1983 and three times in 1984, with a separate check plot for each replication for each year. Data for both years are shown in Table 7. Postemergence grass treatments were applied four weeks after planting in 1983 when red rice was four inches tall or less. In 1984, applications were applied two weeks after planting when red rice was approximately four inches in height. Sequential treatments (graminicide followed by broadleaf herbicide) were applied five days apart both years.

Results and Discussion

At the Alexandria and Baton Rouge locations, grass control was generally higher in 1985 than in 1984 with all herbicides. Dry conditions two weeks prior to treatment application in 1984 may partially explain the yearly variation observed. In contrast, at both the Crowley and St. Joseph locations, sufficient soil moisture existed both years.

With the exception of Baton Rouge in 1985, seedling and rhizome johnsongrass and broadleaf signalgrass control ranged from 77-100 percent control, with Poast at 0.30 pounds of active ingredient per acre

applied alone both years (Table 1). Tank-mixing Poast with broadleaf herbicides resulted in significant reductions in seedling and rhizome johnsongrass control at all locations. At Alexandria, rhizome johnsongrass was reduced more with the tank mixtures in 1985 than in 1984, which may be related to the drier conditions in 1984. At the Alexandria location, reduced grass control was most pronounced with the Poast + Scepter or Classic tank mixtures. Broadleaf signalgrass control was unaffected by the tank mixes at either Baton Rouge or St. Joseph.

Fusilade 2000 in combination with the broadleaf herbicides provided 75-100 percent control of grasses (Table 2). Antagonism associated with the tank mixes was not noted for seedling or rhizome johnsongrass at Alexandria in 1985, and seedling johnsongrass at Baton Rouge and St. Joseph in 1984 and 1985, respectively. Reduced rhizome johnsongrass control associated with tank mixtures was less pronounced with Fusilade 2000 than with Poast. With Fusilade 2000, only tank mixtures with Scepter, Classic, and Cobra were antagonistic in connection with johnsongrass.

Good (81 percent) to excellent (100 percent) control of grasses was obtained with Verdict applied alone at 0.19 pounds of active ingredient per acre, and very little antagonism occurred when tank-mixed with broadleaf herbicides (Table 3). In 1985, Scepter reduced the activity of Verdict by 20 and 39 percent for rhizome johnsongrass at Alexandria and seedling johnsongrass at Baton Rouge, respectively. In 1985 at St. Joseph, combinations of Classic with Verdict resulted in a 25 percent reduction in control of broadleaf signalgrass.

Like Verdict, tank mixtures of Assure with the broadleaf herbicides seldom reduced grass control (Table 4). Good to excellent control of all grass species (86-100 percent) was obtained with Assure applied alone. For rhizome johnsongrass in 1984 at Alexandria, reduced grass control was noted for combinations with Blazer + Basagran (25 percent) and Cobra (41 percent). As noted earlier, this was probably related to dry weather. Seedling johnsongrass control was reduced 35 percent with Blazer at Baton Rouge in 1984, and 34 percent with Scepter in 1985. Antagonism was noted in broadleaf signalgrass control for tank mixtures of Verdict + Blazer, Scepter, Classic, Reflex,and Cobra, but variability in responses between locations occurred.

No significant antagonism occurred when Whip was tank-mixed with broadleaf herbicides to control seedling johnsongrass, regardless of location (Table 5). A significant decrease in rhizome johnsongrass control was noted for Whip tank-mixed with Basagran + Blazer (23 percent), Scepter (48 percent), Classic (25 percent), and Cobra (21 percent). Only the Whip + Classic tank mixture reduced broadleaf signalgrass control (30 percent).

Increasing the rate of grass herbicides in tank mixtures can overcome antagonism, and acceptable control of seedling grasses can be accom-

Table 1.—Effect of Poast tank-mixed with broadleaf herbicides on seedling (SJG) and rhizome (RJG) johnsongrass, and broadleaf signalgrass (BSG) control 3 weeks after application at Alexandria, Baton Rouge, and St. Joseph, LA

		Alexandria				Baton Rouge			St. Joseph	
		SJG		RJG		SJG		BSG	SJG	BSG
Treatment	Rate	1984	1985	1984	1985	1984	1985	1984	1985	1985
	(lbs. ai/A)	(%)								
Poast	0.30	92a[1]	99a	77a	93a	88a	56a	80a	98a	100a
Poast + Blazer	0.30 0.38	93a	96a	74a	64cd	71a	33ab	90a	92ab	98a
Poast + Basagran	0.30 0.75	78ab	98a	67a	83ab	50b	14b	70a	82b	92a
Poast + Blazer + Basagran	0.30 0.38 0.75	92a	100a	59abc	70bc	73a	5b	85a	97a	97a
Poast + Scepter	0.30 0.13	63bc	93a	40c	51d	76a	34ab	79a	97a	98a
Poast + Classic	0.30 0.008	56c	98a	43bc	71bc	71a	33ab	76a	95ab	95a
Poast + Reflex	0.30 0.38	83a	100a	65ab	76bc	83a	53a	81a	92ab	97a
Poast + Cobra	0.30 0.20	95a	100a	73a	66c	74a	23b	80a	87ab	98a

[1]Means within columns followed by the same letter are not significantly different at the 5% level.

Table 2.—Effect of Fusilade 2000 tank-mixed with broadleaf herbicides on seedling (SJG) and rhizome (RJG) johnsongrass, and broadleaf signalgrass (BSG) control 3 weeks after application at Alexandria, Baton Rouge, and St. Joseph, LA

		Alexandria				Baton Rouge			St. Joseph	
		SJG		RJG		SJG		BSG	SJG	BSG
Treatment	Rate	1984	1985	1984	1985	1984	1985	1984	1985	1985
	(lbs. ai/A)	(%)								
Fusilade 2000	0.19	99a[1]	100a	96ab	100a	84a	90a	75a	100a	95ab
Fusilade 2000 + Blazer	0.19 0.38	91ab	100a	76a-f	94a	88a	39c	41b	97a	97ab
Fusilade 2000 + Basagran	0.19 0.75	98a	100a	84a-e	99a	85a	75ab	73a	98a	100a
Fusilade 2000 + Blazer + Basagran	0.19 0.38 0.75	88ab	100a	73b-g	96a	89a	48bc	64ab	98a	98a
Fusilade 2000 + Scepter	0.19 0.13	86ab	98a	63e-h	85a	76a	61abc	55ab	97a	77bc
Fusilade 2000 + Classic	0.19 0.008	79b	99a	53g-i	90a	78a	59abc	55ab	93a	72c
Fusilade 2000 + Reflex	0.19 0.38	98a	100a	89abc	99a	78a	64abc	69a	100a	98a
Fusilade 2000 + Cobra	0.19 0.20	89ab	100a	71c-g	93a	85a	85a	83a	98a	100a

[1]Means within columns followed by the same letter are not significantly different at the 5% level.

Table 3.—Effect of Verdict tank-mixed with broadleaf herbicides on seedling (SJG) and rhizome (RJG) johnsongrass, and broadleaf signalgrass (BSG) control 3 weeks after application at Alexandria, Baton Rouge, and St. Joseph, LA

		Alexandria				Baton Rouge			St. Joseph	
		SJG		RJG		SJG		BSG	SJG	BSG
Treatment	Rate	1984	1985	1984	1985	1984	1985	1984	1985	1985
	(lbs. ai/A)	(%)								
Verdict	0.19	100a[1]	100a	98a	99a	89ab	98a	81ab	99a	93a
Verdict + Blazer	0.19 0.38	99a	100a	96a	93ab	79ab	83ab	76ab	100a	93a
Verdict + Basagran	0.19 0.75	100a	100a	99a	96a	84ab	88ab	90ab	98a	98a
Verdict + Blazer + Basagran	0.19 0.38 0.75	98a	100a	93a	99a	81ab	78ab	74ab	97a	92a
Verdict + Scepter	0.19 0.13	98a	100a	94a	79b	83ab	59b	60b	97a	87ab
Verdict + Classic	0.19 0.008	100a	100a	97a	92ab	68b	85ab	65ab	98a	68b
Verdict + Reflex	0.19 0.38	100a	100a	98a	97a	91ab	79ab	85ab	100a	93a
Verdict + Cobra	0.19 0.20	100a	100a	93a	94ab	84ab	90ab	80ab	100a	98a

[1]Means within columns followed by the same letter are not significantly different at the 5% level.

Table 4.—Effect of Assure tank-mixed with broadleaf herbicides on seedling (SJG) and rhizome (RJG) johnsongrass, and broadleaf signalgrass (BSG) control 3 weeks after application at Alexandria, Baton Rouge, and St. Joseph, LA

		Alexandria				Baton Rouge			St. Joseph	
		SJG		RJG		SJG		BSG	SJG	BSG
Treatment	Rate	1984	1985	1984	1985	1984	1985	1984	1985	1985
	(lbs. ai/A)	(%)								
Assure	0.19	100a[1]	100a	99a	99a	88a	95a	86a	100a	99a
Assure + Blazer	0.19 0.38	95a	100a	81ab	95a	53b	80ab	21c	100a	92ab
Assure + Basagran	0.19 0.75	99a	99a	93ab	95a	81a	94a	80a	100a	99a
Assure + Blazer + Basagran	0.19 0.38 0.75	89a	100a	74bc	96a	73ab	88ab	83a	100a	100a
Assure + Scepter	0.19 0.13	97a	100a	85ab	88a	68ab	61b	66abc	98a	72b
Assure + Classic	0.19 0.008	95a	100a	89ab	96a	73ab	80ab	64abc	97a	75b
Assure + Reflex	0.19 0.38	98a	100a	90ab	99a	81a	90ab	46bc	100a	100a
Assure + Cobra	0.19 0.20	93a	100a	58c	94c	73ab	75ab	40c	97a	98a

[1]Means within columns followed by the same letter are not significantly different at the 5% level.

Table 5.—Effect of Whip tank-mixed with broadleaf herbicides on seedling (SJG) and rhizome (RJG) johnsongrass, and broadleaf signalgrass (BSG) control 3 weeks after application at Alexandria, Baton Rouge, and St. Joseph, LA

		Alexandria		Baton Rouge	St. Joseph	
		SJG	RJG	SJG	SJG	BSG
Treatment	Rate	1985	1985	1985	1985	1985
	(lbs. ai/A)	(%)				
Whip	0.15	99a[1]	96a	50a	100a	70ab
Whip + Blazer	0.15 0.38	99a	91a	24a	87a	75ab
Whip + Basagran	0.15 0.75	100a	91a	49a	97a	85a
Whip + Blazer + Basagran	0.15 0.38 0.75	100a	73b	30a	93a	73ab
Whip + Scepter	0.15 0.13	100a	48c	21a	90a	66ab
Whip + Classic	0.15 0.008	99a	69b	21a	97a	40c
Whip + Reflex	0.15 0.38	100a	91a	29a	95a	68ab
Whip + Cobra	0.15 0.20	100a	75b	35a	97a	58b

[1]Means within columns followed by the same letter are not significantly different at the 5% level.

plished (Table 6). In some cases, significant subsequent improvement can occur. Increasing the application rate of Poast by 50 percent resulted in a significant increase in seedling johnsongrass control (31 percent) when tank-mixed with Basagran. Increasing the rate of Assure by 20 percent increased broadleaf signalgrass control significantly (19 percent) when tank-mixed with Blazer. However, since rate increases do not always counteract antagonism, indiscriminate tank-mixing may not be cost effective.

At Crowley, good to excellent red rice control (82-98 percent) was obtained in 1983 and 1984 when grass herbicides were either applied alone or as sequential treatments (Table 7). Although the yields did not reflect the differential in weed control observed, red rice control ratings were significantly reduced in some cases when grass herbicides were tank-mixed with broadleaf herbicides. Blazer + Basagran in combination with Poast reduced red rice control approximately 10 percent, compared with sequential applications. However, the tank mixtures of Fusilade and Verdict with Basagran + Blazer provided comparable control to that of the sequential treatments. Both the tank mixture and sequential treatments involving Fusilade provided lower red rice control both years compared to Fusilade alone. This was also noted for the Poast and Assure tank mixture and sequential treatments in 1984.

Table 6.—Effect of herbicide tank mixes at various rates on broadleaf signalgrass (BSG) and seedling johnsongrass (SJG) control 3 weeks after application at St. Joseph, LA, 1984

Herbicide	Rate	Weed Control	
		BSG	SJG
	(lbs. ai/A)	(%)	
Poast	0.2	95a[1]	94ab
Poast + Blazer	0.2 + 0.5	83a	70cd
Poast + Blazer	0.3 + 0.5	85a	85abc
Poast + Basagran	0.2 + .75	90a	56d
Poast + Basagran	0.3 + .75	94a	87abc
Poast + Blazer + Basagran	0.2 + 0.25 + 0.5	80ab	73bcd
Fusilade	0.25	96a	96a
Fusilade + Blazer	0.25 + .5	86a	84abc
Fusilade + Basagran	0.25 + 0.75	94a	95ab
Fusilade + Blazer + Basagran	0.25 + 0.25 + 0.75	80ab	85abc
Assure	0.03	98a	98a
Assure + Blazer	0.05 + 0.5	45d	85abc
Assure + Blazer	0.06 + 0.5	64bc	85abc
Assure + Basagran	0.03 + 0.75	85a	90abc
Assure + Basagran	0.06 + 0.75	95a	97a
Assure + Blazer + Basagran	0.03 + 0.25 + 0.75	55cd	81abc

[1]Means within columns followed by the same letter are not significantly different at the 5% level.

Table 7.—Effect of sequential applications and tank mixes of herbicides on red rice control 3 weeks after application and soybean yields at Crowley, LA

Treatment	Rate	Red Rice Control		Yield
		1983	1984	1983
	(lbs. ai/A)	(%)		
Fusilade	0.38	98a[1]	98a	27a
Poast	0.38	97a	96ab	26a
Verdict	0.25	97a	98a	26a
Assure	0.06	—	96ab	—
Fusilade + Basagran + Blazer	0.38 + 0.5 + 0.25	79c	85de	22a
Fusilade fb Basagran + Blazer	0.38 fb 0.5 + 0.25	83bc	89cd	21a
Poast + Basagran + Blazer	0.38 + 0.5 + 0.25	81c	83e	22a
Poast fb Basagran + Blazer	0.38 fb 0.5 + 0.25	91ab	88cd	27a
Verdict + Basagran + Blazer	0.25 + 0.5 + 0.25	94a	95ab	23a
Verdict fb Basagran + Blazer	0.25 fb 0.5 + 0.25	96a	95ab	23a
Assure + Basagran + Blazer	0.06 + 0.5 + 0.25	—	70f	—
Assure fb Basagran + Blazer	0.06 fb 0.5 + 0.25	—	82e	—
Fusilade 2000 + Basagran + Blazer	0.25 + 0.5 + 0.25	—	91bc	—
Fusilade 2000 fb Basagran + Blazer	0.25 fb 0.5 + 0.25	—	92bc	—

[1]Means within columns followed by the same letter are not significantly different at the 5% level.

Summary

With the exception of the Baton Rouge location, grass control was higher and tank mix antagonism lower in 1985 than in 1984. Rainfall accumulation two weeks prior to treatment application in Alexandria may partially explain the differences observed. Sufficient moisture appears necessary for herbicide uptake and subsequent grass control (Retzinger, et al., 1983).

All of the graminicides provided effective control of weed species when applied alone in 1984 and 1985. Verdict, Assure, Fusilade 2000, and Whip were less susceptible than Poast to decreased grass control when tank-mixed with broadleaf herbicides. In at least two locations and/or years, significant antagonism was observed with Blazer in tank mixtures with Poast, Fusilade 2000, and Assure; Scepter in tank mixtures with Poast and Verdict; Classic in tank mixtures with Poast, Fusilade 2000, and Whip; and Cobra in tank mixtures with Poast and Assure.

Sequential treatments (grass herbicide followed 3-5 days later by broadleaf herbicide) were beneficial in providing improved red rice control as compared to tank mixtures.

No crop injury occurred with any of the grass herbicides when applied alone, and only minor leaf injury was noted with some of the tank mixes.

All labels allow tank mixes with certain herbicides, but none allow for all tank mixes discussed in this publication. Also, all labels call for increased rates of the graminicide component when tank-mixing. Although some increase in grass control was obtained with these increased rates, the additional graminicide component requires (by label) an additional 20-50 percent increase, greatly affecting the economics of the mixture.

Overall, results indicate that selective control of annual and perennial grass in soybeans can be achieved. However, tank-mix combinations and rainfall prior to treatment application can affect the consistency of graminicides.

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